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ABSTRACT

This article describes two case studies of children, ages 6 and 8, with severe traumatic brain injuries (TBI) in which direct instruction programs were used to teach a variety of academic skills. Following an initial evaluation, the teacher began individualized instruction 2 to 3 times per week for 6 weeks. After approximately 12 hourly instructional sessions, both students made substantial academic progress in their targeted instructional areas. The gains were seen in both discrete and more complex skills. Both students regained skills lost as a result of their injury and also gained new skills. A table lists learning characteristics of children with TBI and features of the direct instruction approach which address each characteristic. (Contains 13 references.) (DB)

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Using Direct Instruction with Brain Injured Students

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Because of significant advances in medical technology over the past fifteen years, the lives of children and youth who formerly died of traumatic brain injury (TBI) are now being saved in increasing numbers. Each year, approximately 165,000 children and youth require hospitalization for brain injuries sustained in motor vehicle accidents, falls, sports, and physical abuse (Bush, 1986). Of these children, 20,000 will be left with long-lasting alterations in social, behavioral, physical, and cognitive functioning (Kalsbeek, McLaurin, & Harris, 1980; Rosen & Gerring, 1986). The incidence rates for the most severe traumatic brain injuries are higher than those for spinal cord injury, multiple sclerosis, cerebral palsy, and muscular dystrophy combined (Kurtze, 1982).

The growing population of school-aged children with TBI presents teachers with a variety of new challenges. Students with TBI have unique learning characteristics, including problems with concentration, memory, new learning, organization and planning, generalization of new skills, and thinking and reasoning (Savage, 1988).

Direct Instruction (Engelmann & Carnine, 1982) is one of the most promising approaches for teaching academic skills to students with TBI. The design and presentation features of Direct Instruction programs specifically address the learning characteristics of these students. Table 1 presents the most common learning problems associated with TBI and the components of the Direct Instruction approach which address those problems.

This article describes two case studies in which Direct Instruction programs were used to teach a variety of skills to students with brain injuries. The purpose of the studies was to evaluate the effectiveness of Direct Instruction techniques in teaching academic skills to students with severe brain injuries.

Case Studies

The case studies described here were conducted as part of a federally funded project designed to evaluate intervention strategies for families of children with brain injury and the schools that serve these children ("Home/School Support for Families of Children with Traumatic Brain Injury," Singer & Glang, 1989). As part of this project, a free tutoring program was offered to any student with a documented brain injury (i.e., hospitalization following traumatic brain injury with ensuing coma of at least 24 hours). All students who participated were at least *one year post injury*, well beyond the most rapid period of "spontaneous recovery." Instruction was provided by a certified special education teacher who had experience working with brain-injured learners.

Following an initial evaluation, the teacher began individualized instruction with each student. Students were tutored 2-3 times per week for 6 weeks.

Table 1. Learning Characteristics of Children with TBI and Relevant Direct Instruction Features.

Learning Characteristic	Direct Instruction Feature
Concentration	Rapid instructional pacing. Instructional tasks broken down into components. Student engagement maintained through high response and success rates.
Memory	Sufficient practice and review.
New learning	Skills sequenced to build on previous learning. Generalizable strategies. Sufficient practice. Effective use of corrective feedback.
Organization and planning	Problem-solving strategies. Consistent, structured instruction.
Generalization	General-case programming.
Thinking and reasoning	Instruction in generalizable learning and reasoning strategies in addition to instruction in content.

Study 1

Subject

Jill, the subject for study 1, was a 6 year old girl who was injured in a motor vehicle/pedestrian accident 12 months before the study began. As a result of the accident, she sustained a severe brain injury, with evidence of a left temporoparietal contusion. She was comatose for several months, and remained hospitalized for approximately four months.

Prior to beginning the study, Jill was tested using the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) and the Woodcock-Johnson Tests of Achievement (reading subtests only). On the WPPSI, Jill obtained a full scale IQ score of 65 (Verbal IQ score: 64, Performance IQ score: 73). Her reading performance on the Woodcock-Johnson was at the kindergarten level.

When the study began, Jill had just completed kindergarten. She had attended a special education classroom and also received speech, physical, and occupational therapies through the school district.

Procedure

Jill was tutored two to three times per week (12 sessions total). The teacher targeted beginning language and reading skills for instruction. During baseline, Jill was probed on: (1) a list of visually presented sounds, and (2) a series of simple sentences that she was to repeat (e.g. "The big bed was soft," "The fish swims in the water.")

Instruction

The teacher began instruction after baseline performance stabilized. Jill was taught beginning language and reading skills using *DISTAR Language I* (Engelmann & Osborn, 1976) and *Reading Mastery I* (Engelmann & Bruner, 1983). The order of instructional presentation varied each day.

Sentence repetition. The "Identity Statements" strand in *DISTAR Language I* was used to teach Jill to repeat statements. This skill provides the foundation for other comprehension skills and must be mastered before students can be expected to understand written text.

Sound identification. Using the sound identification strand, Jill was taught to identify individual sounds in isolation.

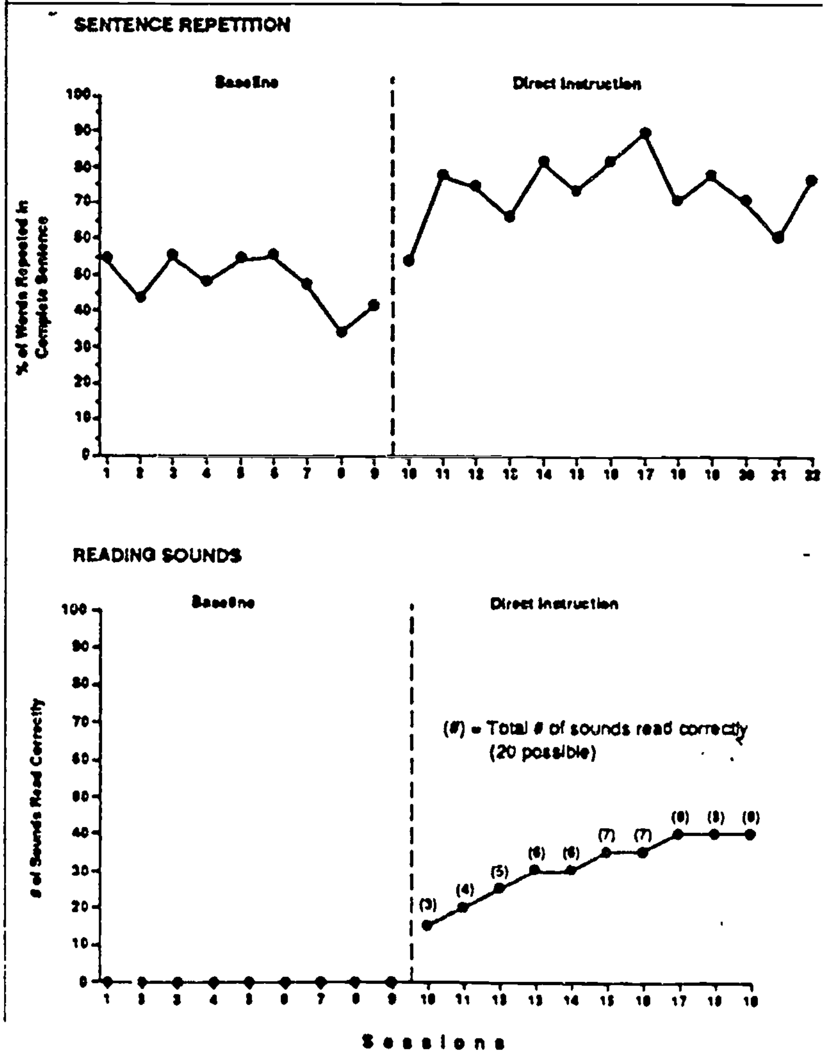
Data collection

Probe data was collected before and after each lesson on sound identification and statement repetition. The teacher wrote down Jill's response to each item and recorded whether it was correct or incorrect. A research assistant independently collected data on 16 of the 46 probes. Interobserver agreement averaged 100% (200 agreements out of 200 responses).

Experimental design

An AB design was used to determine the effectiveness of the instructional program on Jill's reading and language skills.

Figure 1. Effectiveness of Direct Instruction Tutoring in Language and Reading (Jill).



Results

Jill's probe performance is depicted in Figure 1. Significant improvement over baseline levels is apparent in both statement repetition and sound identification.

Statement repetition. On the statement repetition probes during baseline, Jill was able to repeat an average of 47.9% of the words presented. Most of the probe statements consisted of 5-6 words; but Jill was only able to repeat an average of 3 words. For example, when presented with "This tree is tall and green," she repeated, "tall green." When the teacher stated, "She is riding a bicycle," Jill repeated, "riding bicycle." It should be noted that this type of language pattern was consistent with Jill's conversational style. During the instructional period, her performance improved to an average of 72.8%. She repeated most words in all probe statements, and often repeated statements verbatim. Anecdotal reports from Jill's teacher suggested that her spontaneous speech also increased in complexity during the instructional phase.

Sound identification. As a non-reader, Jill was unable to identify any of the 20 sounds presented to her during baseline. With instruction, her performance improved rapidly to an average of 6.2 (31%) correct sounds. Most importantly, she remembered sounds from one session to the next, although there were generally 2-3 days between sessions.

Study 2

Subject

The subject in Study 2, Thomas, was an 8 year old boy who sustained a closed head injury when struck by a motor vehicle 15 months prior to participating in the tutoring program. The accident resulted in a severe skull fracture with subdural hematoma and intraparenchymal hemorrhage. Thomas was comatose for approximately 3 weeks. Prior to the tutoring program, Thomas was assessed using the Wechsler Intelligence Scale for Children-Revised (WISC-R). Thomas achieved a Full Scale IQ score of 81 (Verbal Score of 81, Performance Score of 84).

At the time of his participation in the study, Thomas had just completed the second grade. He received special education services for math and spent the rest of the day in the second grade classroom.

Procedure

Thomas was tutored twice a week over a six week period (13 sessions total). Prior to the baseline phase, the teacher evaluated Thomas and met with his parents and classroom teacher. Based on his educational goals, her assessment, and these discussions, the teacher targeted three instructional areas: deductive reasoning skills, math story problems, and addition and subtraction math facts.

The baseline phase consisted of a series of probes in each instructional area. During each baseline session, Thomas completed: (1) a worksheet with five written story problems, (2) a one minute timing on math facts, and (3) five verbally presented questions involving deductive reasoning skills. Sample items from each of the probes appear in Table 2.

Table 2. Probes for Subject 2.

1. *Math story problem:* Mike builds dog houses for a job. He built 8 dog houses last week. Then he built 17 more dog houses this week. He sold 5 dog houses over the weekend. Mike earns money delivering papers too. He delivers papers 7 days a week. How many dog houses does Mike have built to sell? (20)
2. *Math facts:* Probe sheet consisted of a random selection of addition and subtraction facts (e.g. 7 - 4, 10 - 8, 12 - 9) presented vertically.
3. *Reasoning skills:* All reptiles are cold blooded. A lizard is a reptile. So a lizard (is cold blooded).

Instruction

After establishing baseline performance, the teacher began instruction in each academic area. Instructional order was varied during each session. The teacher taught Thomas using the relevant strands from *Corrective Reading Comprehension, Level A* (Engelmann, Osborn, Haddox, & Hanner, 1978) and *Corrective Mathematics* (Engelmann & Carnine, 1982). The three strands used to teach Thomas are briefly described below.

Reasoning skills. The "Deductions" strand from the *Corrective Reading Comprehension Series* concentrates on teaching reasoning skills central to solving a wide range of problems. As determined by his baseline performance, Thomas needed to begin instruction with the most basic form of deductions: those involving a rule that applies to all members of a class. With this form of deduction, the student learns to apply a "rule" to a specific member of the class.

Math story problems. In working with Thomas, the teacher modified the story problem strategy taught in the *Corrective Mathematics Program* as follows:

When working a story problem, you:

1. First read the question at the end.
2. Underline what you're being asked to find out.
3. Go to the beginning of the problem and read it
4. As you read, underline words that are the *same* as the words in the question.
5. Figure out if you should add up or take away.
6. Do it.
7. Write out the answer.

Thomas was taught to solve both addition and subtraction story problems that contained a variety of distracting information.

Math facts. Over the course of the tutoring program, Thomas practiced five addition fact families (the 5+ series through the 9+ series) and two subtraction fact families (the 9- series and the 5- series).

Data collection

The teacher collected probe data twice during each session (before and after the lesson). Each day, she collected and scored Thomas' worksheets after he had completed them. A research assistant independently scored 24 of Thomas' worksheets (8 from each instructional area). Interobserver agreement on these measures averaged 99% (166 agreements out of 168 responses).

Experimental design

A multiple baseline across content area was used to evaluate the effectiveness of the tutoring program. Instruction was introduced sequentially in each area once baseline performance stabilized.

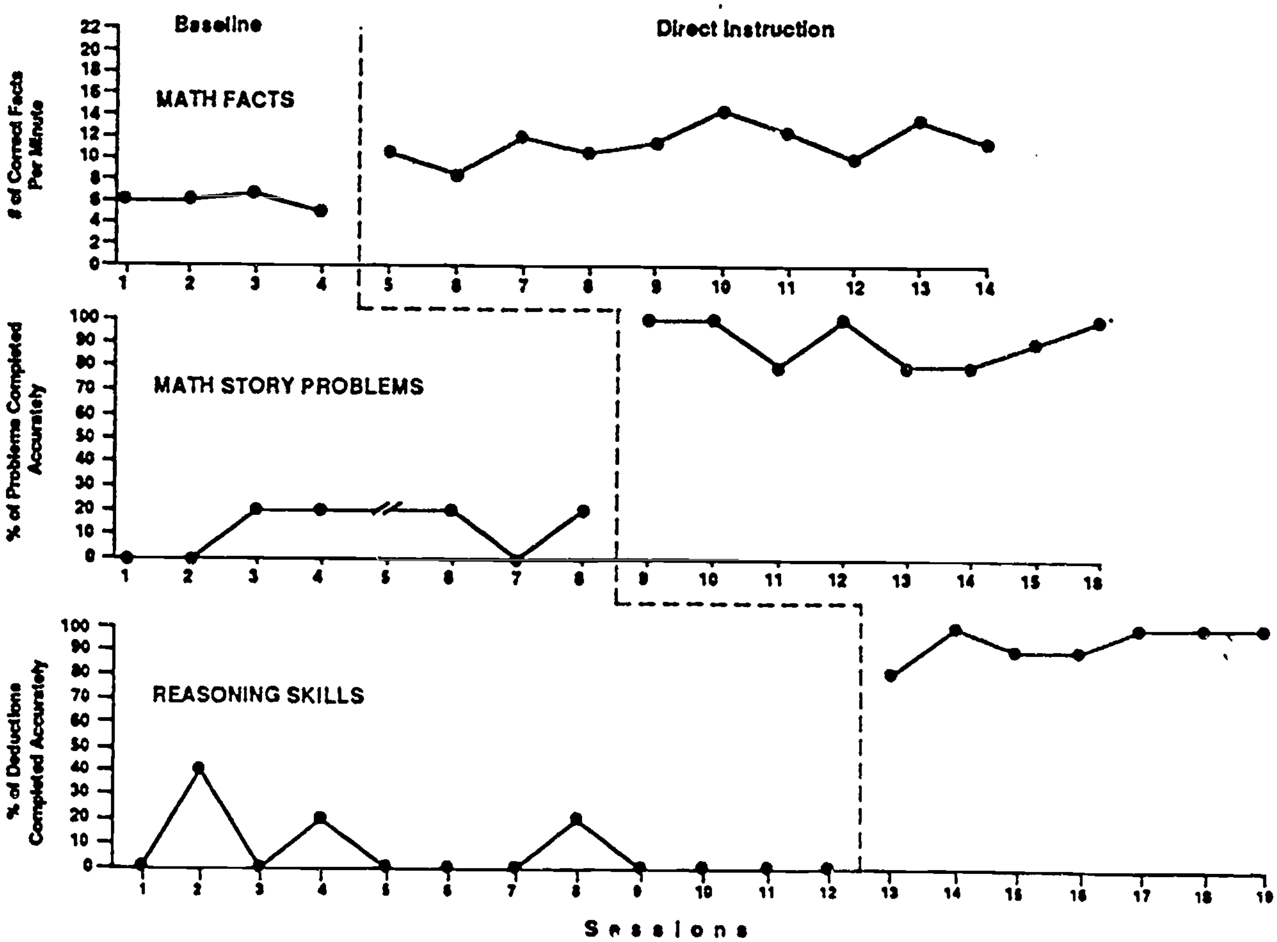
Results

Figure 2 depicts Thomas' performance in each of the three instructional areas. Once instruction was begun, Thomas made immediate and significant improvement in all three areas.

Reasoning skills. During the baseline phase, Thomas averaged 6.7% correct on verbally presented deductions. His responses indicated a complete lack of understanding of the reasoning process, and often included totally irrelevant information. A sample of Thomas' responses (in italics) to the deductive statements presented during baseline follows:

Some ice cream has nuts. Chocolate is one ice cream. So... *lick 'em.*

Figure 2. Effectiveness of Direct Instruction Tutoring in Math Facts, Math Story Problems, and Reasoning Skills (Thomas).



All mice have tails. A field mouse is a type of mouse. So a field mouse... *has little shark teeth.*

Some mountains have tall peaks. Mt. Jefferson is a mountain. So Mt. Jefferson...*doesn't move.*

During the baseline phase, Thomas' responses demonstrated a complete misunderstanding of deductive logic. As soon as instruction began, his performance improved dramatically. He no longer guessed or offered irrelevant responses. For example, several days after instruction began, he responded:

Mammals are warm-blooded. Kangaroos are mammals. So kangaroos... *are warm-blooded.*

Cows don't eat meat. A Guernsey is a cow. So a Guernsey...*doesn't eat meat.*

Thomas' performance maintained at the 80-100% level throughout the instructional period, an acceptable instructional range for a student with learning problems (Anderson, Evertson,& Brophy, 1979).

Story problems. Thomas' performance in story problems followed a similar pattern. As soon as the teacher began instruction in the story problem strategy, his accuracy increased significantly, from an average of 11.4% correct in baseline to an average of 91.25% correct during instruction.

Because all steps in the problem-solving strategy are critical to its successful implementation, it was important for Thomas to learn to follow all steps in the problem-solving strategy. Initially, the teacher guided him through each of the steps, providing corrective feedback as necessary. A key component of the instructional process was to fade these teacher prompts.

Math facts. During the baseline phase, Thomas completed an average of 6 facts per minute. His rate increased to an average of 11.5 facts per minute during the instructional period. Although this represents a significant increase over baseline performance, it is still considerably lower than what an average third grade student could be expected to complete. Thomas' slow performance can primarily be attributed to his poor fine motor skills. If he had given the answers orally rather than in writing, his performance would likely have increased substantially.

Discussion

The results of these two case studies show that the Direct Instruction approach can be effective in teaching children with brain injuries. After approximately 12 hourly instructional sessions, both students made substantial academic progress in their targeted instructional areas. The gains were seen in both discrete and more complex skills. For example, Jill improved in reading sounds and repeating simple sentences, and Thomas learned to work math story problems, a skill involving more abstract reasoning. Obviously, continued Direct Instruction for these children would be important for their future functioning. However, it is a tribute to the power of DI methodology that significant effects can be demonstrated in a short time.

Through participation in the tutoring program, both students regained skills lost after their injury. In addition, some of the gains made represented new learning; Jill, for example, had not had reading instruction prior to the study.

It may be argued that the effects demonstrated in these case studies can be attributed to factors other than the instructional methodology implemented. Students may have improved over the course of the tutoring program due to practice effects or the individualized attention provided by the tutor. Although the design of these studies does not permit an analysis of these questions, research with other populations suggests that the design and presentation variables of Direct Instruction programs are functionally related to student academic gains (e.g., Carnine, 1976; Carnine, 1978; Gersten & Carnine, 1986). Further research is needed to more fully document the effectiveness of these instructional design and presentation variables with the brain injured population. Of specific interest is a more fine-grained analysis of the relative effectiveness of the Direct Instruction design and presentation variables (e.g., cumulative and integrated review, rapid pacing, general-case programming, skills sequencing).

Results from these case studies suggest that the use of Direct Instruction teaching techniques resulted in substantial student progress over a six week period. As the population of children with TBI increases each year, so does the demand for effective approaches to meeting their instructional needs. There is a great need for continued investigation of the effectiveness of Direct Instruction techniques in meeting the the complex instructional needs of students with TBI. ◆

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